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The Improvement of Work Posture Using Rapid Upper Limb Assessment: Analysis to Decrease Subjective Disorders of Strawberry Farmers in Bali

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Abstract

The workload was predicted based on work pulse that was measured using 10 beats method on the radial artery with a stopwatch. The indication of subjective disorders was measured based on the farmers' general fatigue and musculoskeletal disorders before and after work. General fatigue was measured using 30 Items Self-Rating Questionnaire Industrial Fatigue Research Committee from Japan Association of Industrial Health, while musculoskeletal disorders were measured using NIOSH Nordic Body Map Subjective Filling. Environment temperature was measured using sling Psychrometer. The noise was measured using Gossen's sound level meter. Statistical analysis to find out the mean difference of the data before and after work was analyzed using t-Paired test with significance level of 5%. RULA result recommended changing from bending work posture using the old tool into standing work posture using new hole maker. The old work posture (P0) showed RULA grand score of 7 with high-risk level, while the new work posture (P1) showed RULA grand score of 3 with low-risk level. There was a significant difference in subjective disorders of the farmers ($p<0.05$) on P0 and P1 on general fatigue and musculoskeletal disorders. The fatigue score of P0 was 51.27 while P1 was 40.82 which meant there was a reduction of 20.4%. While the musculoskeletal disorders score of P0 was 70.75 and P1 was 50.58 which meant there was a reduction of 28.5%. It can be concluded that the improvement of work posture using RULA analysis decreases work risk level and subjective disorders of strawberry farmers in Bali.

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1. Introduction

Nowadays, Indonesian farmers need attention from the government and many parties. The food security-programmed by the government also depends on the quality of the existing farmers. One of many attentions given to farmers is how we improve the work system to make farmer healthier, empowered and productive in working.

There are many tools used by the farmers that still do not fit the farmers' anthropometry, thus they can cause awkward work postures such as bending work posture. These awkward postures can cause fatigue easily (Adiatmika *et al.,* 2007), musculoskeletal disorders. Fatigue and musculoskeletal disorders are common subjective disorders faced by workers or farmers.

The same thing also happens to strawberry farmers in Bali. Inland management for strawberry planting, farmers cover the soil using mulch plastic to prevent the growth of weeds and to keep soil moisture. Then holes are made on the mulch plastic as a place to plant strawberry seeds. The holes are made using a simple tool in form of the can which is filled with burning coals. The can is given a handle and heated using burning coals and then the heated can is stuck to the mulch plastic to create holes on it. In this activity, the farmers use bending work posture during making a hole on the mulch plastic. As a result, there are subjective disorders from the farmers in form of musculoskeletal disorders and easily to get tired.

To overcome these problems, an analysis of work posture and alternative tool change was conducted to decrease farmers' subjective disorders and to speed up their work. One of many work posture analyses that fit is using RULA (Rapid Upper Limb Assessment) method. RULA is a method to assess posture, style, and movement of a working activity that is related to the use of an upper limb. This method can be used to investigate the risk of abnormality that will be experienced by a worker when doing his / her job. By using RULA method, we can: a) do a preliminary analysis that can determine how much worker's risk of being influenced by the cause of injury factors; they are posture, static muscle contraction, repetitive movement and style, b) decide work priority based on injury risk factor, c) compare how much the influence of an improvement over a work by comparing the assessment before and after the improvement applied. By using this method, a maximum limit score and many kinds of work posture can be gotten, the limit scores range from 1 to 7 (Adiputra *et al.,* 2000).

2. Materials and Methods

This research was conducted experimentally using pre- and post-test group design (same subject). The total sample was 12 farmers which were given two treatments; P0 (making holes on strawberry's plastic mulch seedbed using old method) and P1 (making holes on strawberry's plastic mulch seedbed using a new method that is using new hole maker based on ergonomic approach and RULA analysis). The workload was predicted based on work pulse that was measured using 10 beats method on the radial artery with a stopwatch. The indication of subjective disorders was measured based on the farmers' general fatigue and musculoskeletal disorders before and after work. General fatigue was measured using 30 Items Self-Rating Questionnaire Industrial Fatigue Research Committee from Japan Association of Industrial Health, while musculoskeletal disorders were measured using NIOSH Nordic Body Map Subjective Filling. Environment temperature was measured using sling Psychrometer. The noise was measured using Gossen's sound level meter. Statistical analysis to find out the mean difference of the data before and after work was analyzed using t-Paired test with significance level of 5%.

3. Results and Discussions

3.1 Research Subject Characteristics

The research subject characteristics covered age, body weight, body height, and working experience. The resulting analysis is shown in Table 1 below.

Table 1
Research Subject Characteristics

No	Variables	Mean	SD	Range
1	Age (years old)	37.21	3.24	31 – 42
2	Body weight (kg)	61.19	3.07	57.5 – 69.5
3	Body height (cm)	166.06	4.24	160 – 171
4	Working experience (years)	5.23	4.28	2 – 12
5	Body Mass Index	22.08	1.42	21.74 – 23.17

In Table 1 it can be seen that the mean of subjects' age was 37.21 ± 3.24 years old. This meant that the subjects were on the productive age of working. Body mass index was in the range of 21.74 – 23.17 with a mean of 22.08 or on normal condition (neither thin nor fat). These subjects' condition was still in the optimum physical condition to work. Age influences physical working ability or muscle strength of a person. The maximum physical strength of a person is achieved at age of 25 – 35 years old and they will continue to decrease as the person is getting old (Anna and Tadeusz, 2013)

3.2 Work Environment Condition

The work environment condition covered temperature, relative humidity, wind speed, and sound intensity. Prior to the environmental effect test, a test of data normality toward environment components was conducted using the Shapiro Wilk test, the result showed that all data were normally distributed. The analysis result of work environment condition is shown in Table 2.

Table 2
The environment condition where the research was conducted

No	Variables	Group P0		Group P1		t	p
		Mean	SD	Mean	SD		
1	Temperature (°c)	27.23	2.17	26.12	1.31	-1.059	0.107
2	Relative humidity (%)	74.86	3.24	75.11	3.73	0.509	0.089
3	Light intensity (lux)	362.24	34.63	359.46	37.44	-1.278	0.208
4	Wind speed (m/s)	0.51	0.14	0.49	0.12	-1.041	0.130
5	Sound intensity (dBA)	67.92	2.12	68.14	2.67	1.219	0.147

*SD = Standard Deviation

Based on Table 2, it shows that both farmers' work environment condition of group P0 and P1 were still on the limits of adaptation to perform a work activity. The variables of wet-bulb temperature, dry-bulb temperature, humidity, ball temperature, wind speed, and noise did not have a significant difference between each group of treatment ($p>0.05$), thus it could be concluded that the environmental conditions of P0 and P1 were the same.

The threshold value of air temperature for the worker is 33° C and the relative humidity of Indonesian worker that is still categorized in the comfort zone are between 70% - 80%, especially on small size industries (Arimbawa *et al.,* 2009). The highest threshold value of sound that is still acceptable by a worker without causing permanent hearing disorder for less than 8 work hours a day is 85 dBA (Bridger, 2003).

3.3 RULA Analysis

In the process of making mulch plastic hole maker using the old method, the farmers' work posture was bending as shown on Picture 1 below.

Picture 1. Work posture on making holes on the mulch plastic before the improvement

Picture 2. Work posture after the improvement

Table 3
RULA Analysis

	Before improvement score	After improvement score
Upper Arm	3	2
Forearm	3	1
Wrist	4	2
Wrist Twist	1	1
Posture A	5	3
Muscle	1	1
Force Load	1	1
Wrist and Arm	6	2
Neck	4	3
Trunk	3	1
Leg	2	1
Posture B	7	3
Neck, Trunk, and Leg	8	3
Grand Score	7	3

In Table 3, the score grand of work posture before the improvement was 7 which meant high-risk level that required investigation and changes soon. While the RULA analysis grand score after the improvement was 3 which meant low-risk level. By using RULA analysis there was a decreasing grand score from 7 to 3 or risk level from high to low.

The improvement of work posture to decrease the risk score can use the application of ergonomic. The highest score signifies level that causes big risk or dangerous to be done at work. It also does not mean that the lowest score will guarantee that the examined job is free from ergonomic hazard. Therefore, RULA method is developed to detect work posture that has a risk and the improvement can be conducted soon (BSN, 2004). RULA method is conducted to correct the awkward work posture into a more natural work posture. The incorrect work posture, awkward and unnatural will add the risk of injury on musculoskeletal (Freivalds, 2008). For that reason, improvement toward unnatural work posture needs to be done.

3.4 Subjective Disorders

Subjective disorders are measured based on general fatigue and musculoskeletal disorders. The analysis result of subjective disorders is shown in Table 4 below.

Table 4
The analysis results of subjective disorders

Subjective Disorders	Before Improvement (P0)		After Improvement (P1)		z	p
	Mean	SD	Mean	SD		
General fatigue before work	32.02	0.50	31.68	2.31	-1.578	0.115
Musculoskeletal disorders before work	37.36	1.52	36.92	1.34	-0.445	0.656
General fatigue after work	51.27	5.98	40.82	3.39	-3.061	0.002
Musculoskeletal disorders after work	70.75	2.85	50.58	3.07	-3.059	0.002

The analysis result shows that the mean score of musculoskeletal disorders and general fatigue score before work (Pre) between groups of treatment (P0 and P1) was not significantly different ($p > 0.05$). This shows that the subjects' disorders condition at the beginning can be stated as not different or give the same effect toward both treatments.

Subjective disorders after work, both on fatigue and musculoskeletal disorders, showed significant difference $p<0.05$. Based on the means of P0 and P1, there was a decrease in both general fatigue and musculoskeletal disorders. The P0 fatigue score was 51.27 while P1 was 40.82 or having a decreased 20.4%. While on musculoskeletal disorders, the P0 score was 70.75 and the P1 score was 50.58 or having a decreased 28.5%.

The decrease of this subjective disorders happened because there was a change in work posture from P0 to P1. The bending work posture of P0 was unnatural work posture thus it quickly caused fatigue and musculoskeletal disorders. While standing work posture on P1 was a natural work posture. The change of work posture also changed the work tool into the one that suitable with the work posture. The new work tool of P1 was a form of efficient technology that was useful for farmers. The change of work tool that is suitable with the worker's anthropometry will make the worker feels more comfortable in working using more natural work posture (Hari *et al.,* 2007).

The work system improvement actively involves workers and technicians from the start which is conducted using the total ergonomic approach (Kasper and Per, 2014). The change of work posture that based on the recommendation from the analysis result of work posture using RULA method requires ergonomic study so that the change does not cause a new problem for the workers/farmers. An ergonomic study that is holistic and appropriate in handling the worker's problem is a total ergonomic approach (Kroemer and Grandjean, 2009).

Ergonomics intervention to improvement work posture or workstation its needed especially at small scale industry and agronomy in Indonesia (Loo and Paul, 2015). Agro-ergonomics approach will play an important role in improving the productivity of farmers (Loo and Paul, 2015; Lueder, 1996). Because ergonomics intervention can decrease workload or subjective complaint also increase work productivity (Manuaba, 2006; 2007). By applying ergonomics, the design of a working system to improve work posture and increase productivity should be done (Manuaba, 2005). Ergonomics applications also can improve work performance and ergonomics can also have a good effect on the health for the workers (McAtamney and Corlett, 1993; Pungus *et al.,* 2010; Sucipta, 2006).

4. Conclusion

Based on the discussion above, conclusions can be derived as follow. [a] Work posture improvement of strawberry farmers in Bali using RULA analysis decreased the work risk level from a high level into a low level. [b] Work posture improvement using RULA analysis could decrease the subjective disorders in form of general fatigue and musculoskeletal disorders of strawberry farmers in Bali.

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Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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